Claudia Tierno Ros et al.: Vienna SAC-SOS: Analysis of the European VLBI Sessions, IVS 2012 General Meeting Proceedings, p.324–328
http://ivscc.gsfc.nasa.gov/publications/gm2012/TiernoRos.pdf

Vienna SAC-SOS: Analysis of the European VLBI Sessions

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Abstract

The Institute of Geodesy and Geophysics (IGG) of the Vienna University of Technology as an IVS Special Analysis Center for Specific Observing Sessions (SAC-SOS) has analyzed the European VLBI sessions using the software VieVS. Between 1990 and 2011, 115 sessions have been carried out. The analyzed baselines have lengths ranging from approximately 445 to 4580 km, and they show good repeatabilities, apart from the ones containing station Simeiz. The station velocities have also been investigated. The stations situated in the stable part of Europe have not shown significant relative movements w.r.t. Wettzell, whereas the stations located in the northern areas have the largest vertical motions as a result of the post glacial isostatic rebound of the zone. The stations placed in Italy, around the Black Sea, in Siberia, and near the Arctic Circle show the largest relative horizontal motions because they belong to different geodynamical units.

1. European Geodetic VLBI Network

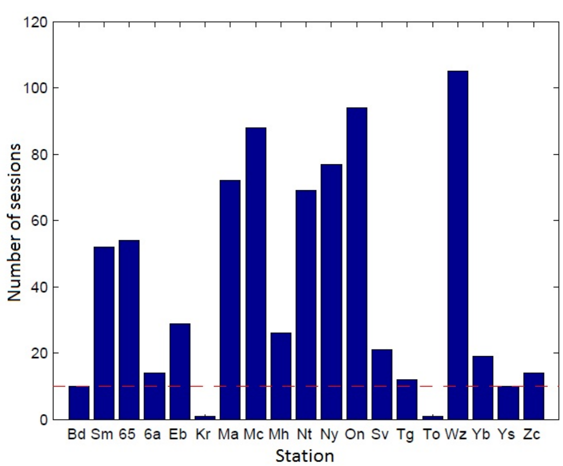

Figure 1. Number of sessions per station.

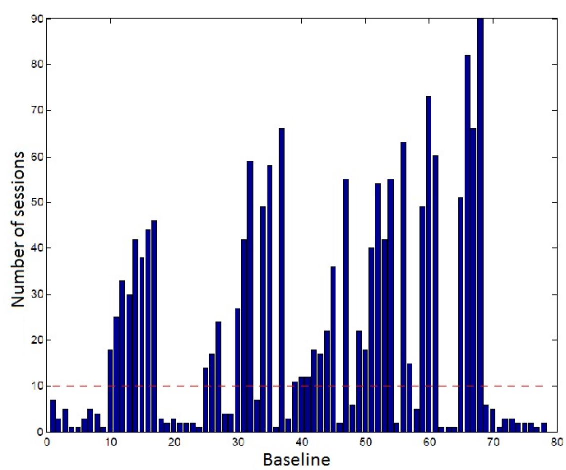

Figure 2. Number of sessions per baseline.

Between 1990 and 2011, 115 European geodetic VLBI network sessions have been carried out (session EUR114, November 2011, was still not correlated at the time of this work). The number of sessions per year varies between three and seven. Their purpose is to determine the station coordinates and their evolution. A total of 19 stations have been taking part in these experiments, on average 7 per session. However, in this paper only stations that observed in more than 10 sessions are considered (it implies an observation time of at least 2 years), so that only the data of 17 stations have been used (Figure 1).

All sessions are of good quality, meaning that the variance factor a posteriori $\chi^2 < 1.5$, where χ^2 is given by Equation 1:

$$\chi^2 = \frac{v^T P v}{n - u} \tag{1}$$

where v are the corrections, P the weights, n the number of observations, and u the number of unknown parameters.

From a total of 78 observed baselines only 40 were used in this analysis which were observed in more than 10 sessions (Figure 2).

It should be mentioned here that the VieVS [3] default parametrization was used in this work (Table 1).

Table 1. VieVS default parametrization.

Parameter	**Default value**
ITRF	VTRF2008 [1]
ICRF	ICRF2 [5]
Ephemeris	JPL421
EOP	C04 08
A priori offsets for nutation	yes
Highfrequency ERP	yes
Libration	yes
Precession/Nutation	IAU2006/200A
Station corrections	
Earth tides	yes
Ocean tides	yes
Atmospheric tides	yes
Atmospheric load	yes
Polar tides	yes
Thermal antenna deformation tides	yes
Pressure and temperature	NGS file
Mapping function	VM1 [2]
Ionosphere	NGS file
Cut-off elevation angle	0
Quality code limit	0

2. Repeatabilities

The 40 baselines used in this work have lengths ranging from approximately 445 to 4580 km. Figure 3 shows the repeatabilities of the baseline length measurements, i.e., the standard deviations after removing the trend, and an exponential interpolation has been used to represent graphically these repeatabilities, rather than a quadratic one [8], since it shows the best fitting. It is noticeable that baselines that contain the station Simeiz have worse repeatabilities than other baselines, which could be due to some technical problems at the Simeiz telescope [7]. Baselines Effelsberg–Wettzell and Metsähovi–Ny-Ålesund also have a higher standard deviation than expected.

Figure 3 also shows the repeatabilities of CONT05 for comparison purposes. CONT05 presents a better repeatability, which could be due to the fact that the European VLBI sessions cover a time span of 20 years and CONT05 covers only 2 weeks, thus being free from seasonal effects that could affect the repeatability. Repeatabilities of the European VLBI sessions are also affected by the worse repeatabilities of baselines to station Simeiz and the baselines Effelsberg–Wettzell and Metsähovi–Ny-Ålesund mentioned above.

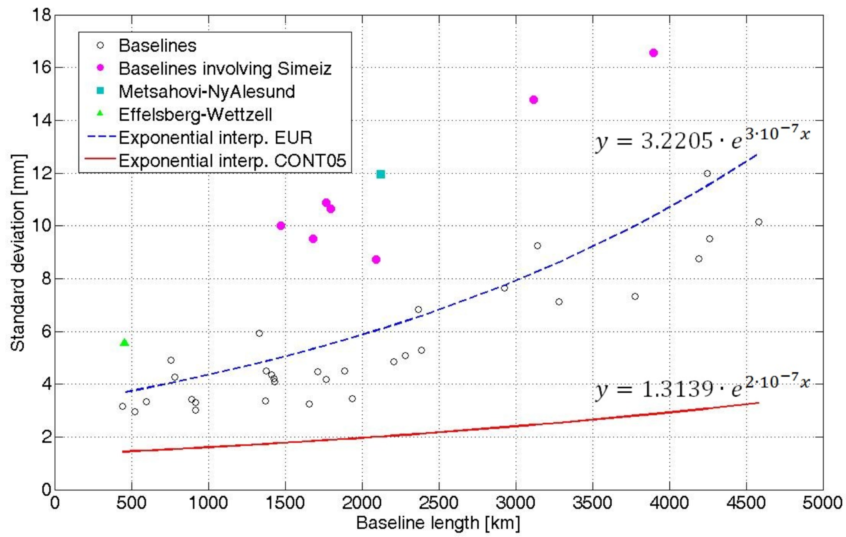

Figure 3. Baseline length repeatability.

The repeatability of the vertical coordinates of the stations has also been studied. There is no correlation between the vertical coordinate of a station and its formal error. However, these height estimates have to be treated with care due to the small extension of the network and the NNR/NNT condition applied.

3. Station Velocities

In this work, station velocities have also been calculated (in Figure 4, arrows correspond to horizontal motion and circles represent vertical movements). All stations present a similar horizontal movement in the Northeast direction, and comparisons with the NUVEL-1A Plate Tectonic model have shown that it corresponds to the movement of the Eurasian plate.

Figure 5 shows the station velocities with respect to Wettzell (situated in the stable part of Europe and at the center of the network). The results obtained here agree with the ones obtained by Haas et al. (2000) [6]. The stations Madrid, Yebes, and Effelsberg do not show significant shifts as they are situated on the same geodynamical unit as Wettzell, while the Italian stations present substantial displacements in the Northeast direction due to the motion of the African plate with respect to the Adriatic plate. The movements of the Northern stations (Ny-Ålesund, Onsala, Metsähovi, and Svetloe) are due to the post glacial isostatic rebound of the area. Station Badary, which is quite far away from the other stations and situated on the other side of the Eurasian plate, shows a different behavior and has been omitted in Figures 4 and 5.

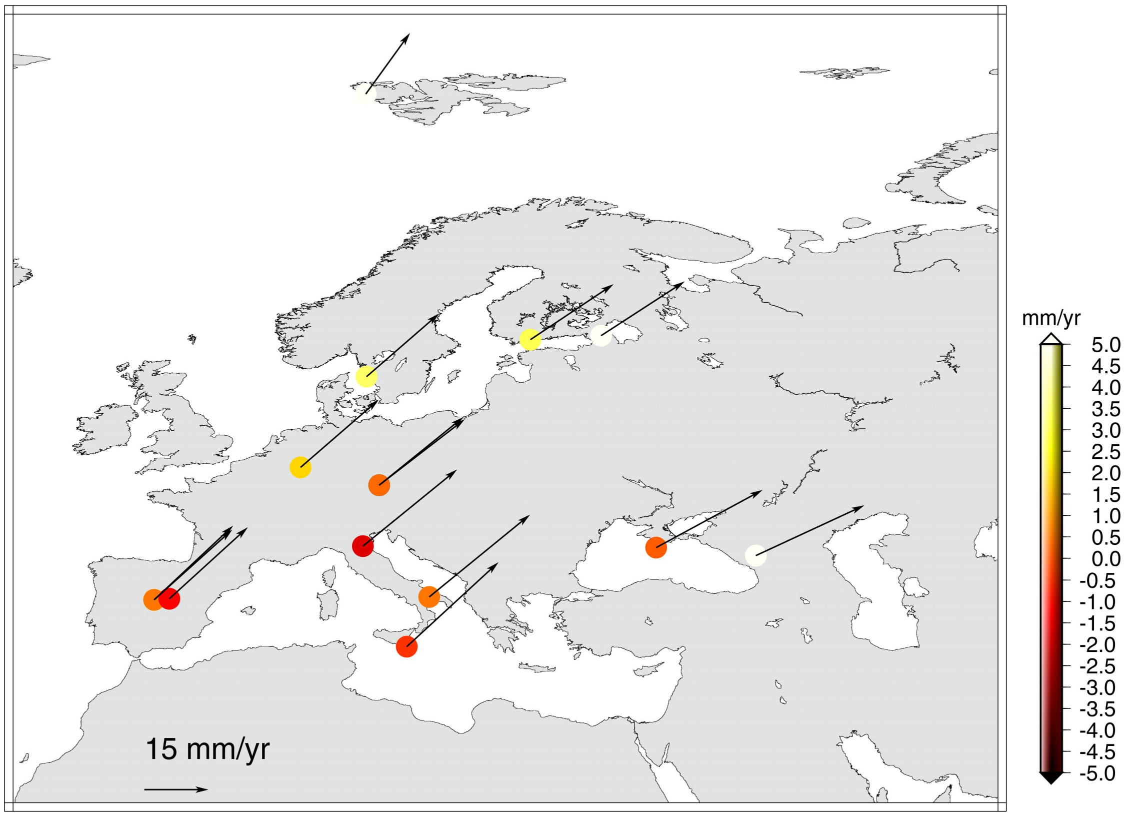

Figure 4. Station velocities: arrows correspond to horizontal motion, and circles represent vertical movements.

Acknowledgements

The authors would like to thank the Austrian Science Fund (FWF) for supporting this work (Project: P24187-N21). They would also like to thank the International VLBI Service for Geodesy and Astrometry (IVS) and all stations which compose the European geodetic VLBI network.

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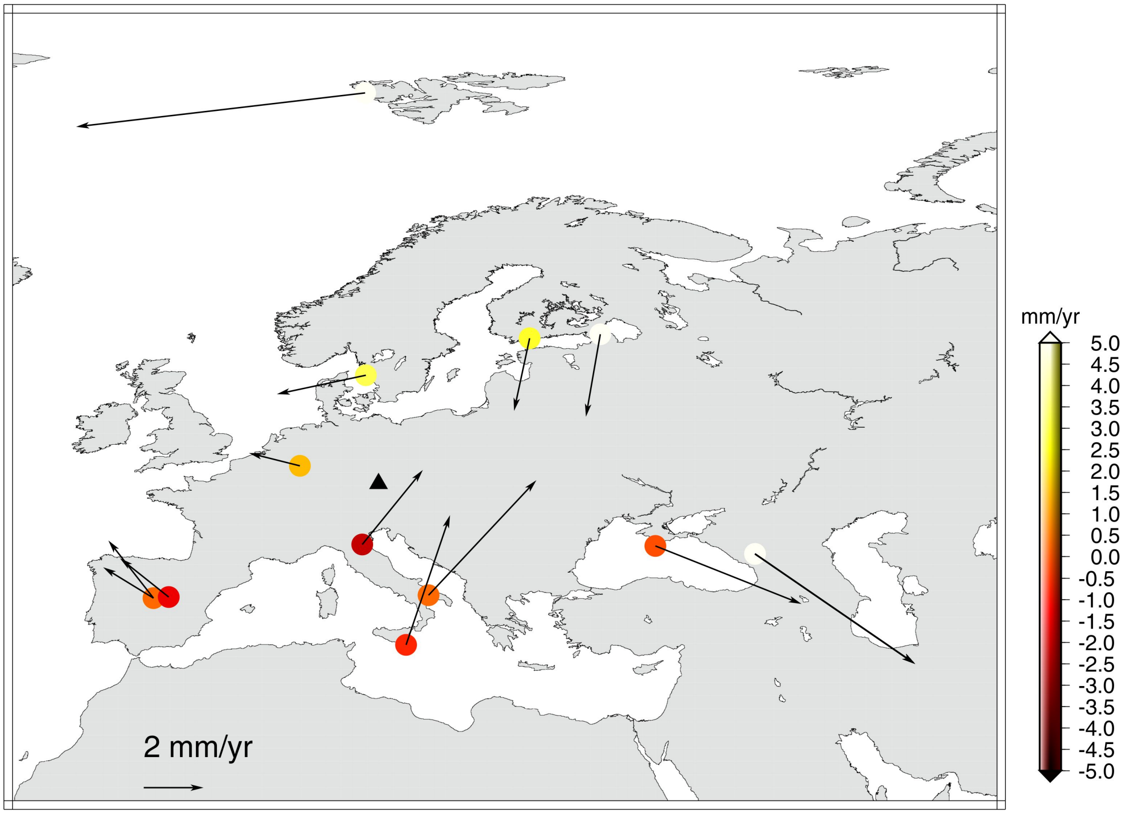

Figure 5. Station velocities with respect to Wettzell: arrows correspond to horizontal motion, and circles represent vertical movements.

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